WE CLAIM:

1. A method of transmitting over four transmit antennas comprising:

for each antenna, generating a respective sequence of OFDM symbols, each OFDM symbol having a plurality of sub-carriers carrying at data or pilots, and transmitting the sequence of OFDM symbols;

wherein pilots are inserted for the four antennas collectively in blocks of two sub-carriers by two OFDM symbols scattered in time and frequency.

2. The method of claim 1 wherein pilots are inserted for the four antennas collectively in blocks of two sub-carriers by two OFDM symbols scattered in time and frequency by:

inserting such blocks of two sub-carriers by two OFDM symbols scattered in a first regularly spaced pattern in even pairs of OFDM symbols;

inserting such blocks of two sub-carriers by two OFDM symbols scattered in a second regularly spaced pattern offset from said first regularly spaced pattern in odd pairs of OFDM symbols.

3. The method of claim 2 wherein the first regularly spaced pattern comprises a repeating pattern of two pilot sub-carriers, ten data sub-carriers and the second regularly spaced pattern comprises six data sub-carriers followed by a repeating pattern of two pilot sub-carriers and ten data sub-carriers.

4. The method of claim 1 wherein each block of two sub-carriers by two OFDM symbols comprises a single pilot for each of the four antennas in a respective position within the block.

5. The method of claim 4 wherein the single pilot for each of the four antennas takes the same position in every block of two sub-carriers by two OFDM symbols.

6. The method of claim 1 wherein each block of two sub-carriers by two OFDM symbols is divided into pilot pairs, each pilot pair being transmitted by a respective pair of antennas.

7. The method of claim 6 wherein each pilot pairs is arranged sequentially in time.

8. The method of claim 6 wherein each pilot pair is arranged sequentially in frequency.

9. The method of claim 1 wherein pilots are inserted for the four antennas collectively in blocks of two sub-carriers by two OFDM symbols scattered in time and frequency in a repeating pattern of six OFDM symbols comprising each comprising a first, second and third pair of OFDM symbols, the method comprising:

inserting such blocks of two sub-carriers by two OFDM symbols scattered in a first regularly spaced pattern in each first pair of OFDM symbols;

inserting such blocks of two sub-carriers by two OFDM symbols scattered in a second regularly spaced pattern offset from said first regularly spaced pattern in each second pair of OFDM symbols; and

inserting such blocks of two sub-carriers by two OFDM symbols scattered in a third regularly spaced pattern offset from said second regularly spaced pattern in each third pair of OFDM symbols.

10. The method of claim 1 wherein pilots are inserted for the four antennas collectively in blocks of two sub-carriers by two OFDM symbols scattered in time and frequency in a repeating

pattern of OFDM symbols that is a multiple of two OFDM symbols in length.

11. A method of transmitting over four transmit antennas comprising:

for antenna, generating a respective sequence of OFDM symbols, each OFDM symbol having a plurality of sub-carriers carrying at data or pilots, and transmitting the sequence of OFDM symbols;

wherein for a first pair of the four antennas, pairs of pilots are inserted scattered in time and frequency;

wherein for a second pair of the four antennas, pairs of pilots are inserted scattered in time and frequency in locations different from pilots for the first pair of antennas.

12. The method of claim 11 wherein for each pair of two pilots, the two pilots are not consecutive in time or frequency.

13. The method of claim 11 wherein for each pair of two pilots, the two pilots are arranged consecutively in time.

14. The method of claim 11 wherein pilots are inserted in a repeating pattern of six OFDM symbols comprising each comprising a first, second and third pair of OFDM symbols, wherein each pair of pilots is arranged sequentially in time:

inserting pilot pairs for the first pair of antennas scattered in a first regularly spaced pattern in each first pair of OFDM symbols;

inserting pilot pairs for the first pair of antennas scattered in a second regularly spaced pattern offset from said first regularly spaced pattern in each second pair of OFDM symbols;

inserting pilot pairs for the first pair of antennas scattered in a third regularly spaced pattern offset from said second regularly spaced pattern in each third pair of OFDM symbols;

inserting pilot pairs for the second pair of antennas scattered in a fourth regularly spaced pattern in each first pair of OFDM symbols offset from said first pattern;

inserting pilot pairs for the second pair of antennas scattered in a fifth regularly spaced pattern offset from said fourth regularly spaced pattern and said second regularly spaced pattern in each second pair of OFDM symbols;

inserting pilot pairs for the second pair of antennas scattered in a sixth regularly spaced pattern offset from said fifth regularly spaced pattern and said third regularly spaced pattern in each third pair of OFDM symbols.

15. A method of transmitting over four transmit antennas comprising:

for each antenna, generating a respective sequence of OFDM symbols, each OFDM symbol having a plurality of sub-carriers carrying at data or pilots, and transmitting the sequence of OFDM symbols;

wherein pilots are arranged in groups of four consecutive pilots in time, each group of four consecutive pilots containing pilots for the four antennas.

16. The method of claim 15 wherein such groups of four consecutive pilots are inserted in each set of four consecutive OFDM symbols, and in each of a plurality of spaced sub-carriers.

17. The method of claim 15 wherein each group of four consecutive pilots comprises a pair of space time coded pilots for a first pair of antennas of the four antennas, and a pair of space time coded pilots for a second pair of antennas of the four antennas.

18. The method of claim 15 wherein each group of four consecutive pilots comprises a single pilot for each of the four antennas.

19. The method of claim 18 wherein the location of the single pilot for each antenna varies across groups of four consecutive pilots.

20. The method of any preceding claim further comprising:

using different pilot patterns for respective four antenna transmitters to reduce interference between pilots of different four antenna transmitters.

21. The method of any preceding claim further comprising:

transmitting pilots with a power higher than average power.

22. The method of claim 21 wherein data and pilots are transmitted using QPSK, with the pilots being transmitted with a relative power boost.

23. The method of claim 21 wherein data is transmitted using a QAM constellation, and pilots are transmitted using QPSK with signal constellation points at corners of the QAM constellation.

24. The method of any preceding claim further comprising transmitting at least one fixed pilot for each of at least one of the four antennas.

25. The method of any preceding claim further comprising transmitting at least one fixed pilot for each of two pairs of antennas within said four antennas.

26. The method of any preceding claim further comprising transmitting at least one fixed signalling channel for each of two pairs of antennas within said four antennas.

27. The method of any preceding claim further comprising:

transmitting relatively reliable signalling channel information proximal in time and frequency to locations of pilots.

28. The method of claim 27 wherein transmitting relatively reliable signalling channel information proximal in time and frequency to locations of pilots comprises:

for pairs of antennas of the four antennas, transmitting space time coded signalling channel information pairs adjacent in time to pairs of pilots.

29. The method of any preceding claim wherein for a given antenna, a spacing between pilots in the time direction is determined with consideration to the maximum Doppler frequency, while a spacing between pilot in the frequency direction is determined with consideration to a delay spread of multi-path fading.

30. A method of transmitting over four transmit antennas comprising:

for each antenna, generating a respective sequence of OFDM symbols, each OFDM symbol having a plurality of sub-carriers carrying at data or pilots, and transmitting the sequence of OFDM symbols;

wherein the OFDM symbols include at least one preamble OFDM symbol or midamble OFDM symbol comprising a repeating pattern of four pilot sub-carriers for the four antennas.

31. The method of claim 30 wherein the repeating pattern of four pilot sub-carriers comprises a first space-frequency coded pilot pair for a first pair of the four antennas, and a second space-frequency coded pilot pair for a second pair of the four antennas.

32. The method of claim 30 wherein the repeating pattern of four pilot sub-carriers comprises a respective pilot for each of the four antennas without overlapping.

33. The method of any one of claims 30-32 wherein the preamble comprises two identical OFDM symbols.

34. The method of claim 33 further comprising transmitting the pair of identical OFDM symbols by:

transmitting a prefix;

transmitting a first OFDM symbol having first and second portions in time, the second portion being identical to the prefix, such that the prefix functions as a cyclic prefix for the first OFDM symbol;

transmitting a second OFDM symbol identical to the first OFDM symbol, such that the second portion of the first OFDM symbol functions as a prefix for the second OFDM symbol.

35. A method of claim 34 wherein the prefix and pair of identical symbols are transmitted with a total time duration equal to a time for transmitting a prefix and a single OFDM symbol that is not part of the preamble or midamble.

36. The method of any preceding claim wherein antennas can be turned off and pilot groups assigned to the turned off antennas re-assigned to the remaining two transmit antennas to improve the channel estimation performance for fast frequency selective fading channel.

37. The method of any one preceding claim wherein the four transmit antennas form part of a single base station transceiver.

38. The method of any one of claims 1 to 36 wherein the four transmit antennas form part of multiple base station transceivers.

39. The method of any one of claims 1 to 36 wherein the four transmit antennas form part of multiple mobile stations.

40. The method of any one of claims 1 to 36 wherein the pilots are space-time coded.

41. The method of any one of claims 1 to 36 wherein the pilots are space-frequency coded.

42. The method of any one of claims 1 to 36 wherein the pilots are space-time-frequency coded.

43. The method of any preceding claim wherein the pilots are uncoded.

Following claim covers 2 or more antennas

44. A method of transmitting over at least two transmit antennas comprising:

for each antenna, generating a respective sequence of OFDM symbols, each OFDM symbol having a plurality of sub-carriers carrying at data or pilots, and transmitting the sequence of OFDM symbols;

wherein pilots are inserted for the antennas collectively in blocks of two sub-carriers by two OFDM symbols scattered in time and frequency.

45. A method of transmitting a pair of identical OFDM symbols comprising:

transmitting a prefix;

transmitting a first OFDM symbol having first and second portions in time, the second portion being identical to the prefix, such that the prefix functions as a cyclic prefix for the first OFDM symbol;

transmitting a second OFDM symbol identical to the first OFDM symbol, such that the second portion of the first OFDM symbol functions as a prefix for the second OFDM symbol.

46. A transmitter comprising four transmit antennas, the transmitter being adapted to implement the method of any one of claims 1 to 36, 40 to 43.

47. At least two base station transceivers collectively comprising four transmit antennas, the at least base station transceivers adapted to implement the method of any one of claims 1 to 36, 40 to 43.

48. At least two mobile stations collectively comprising four transmit antennas, the at least two mobile stations adapted to implement the method of any one of claims 1 to 36, 40 to 43.